PATENT ABSTRACTS OF JAPAN

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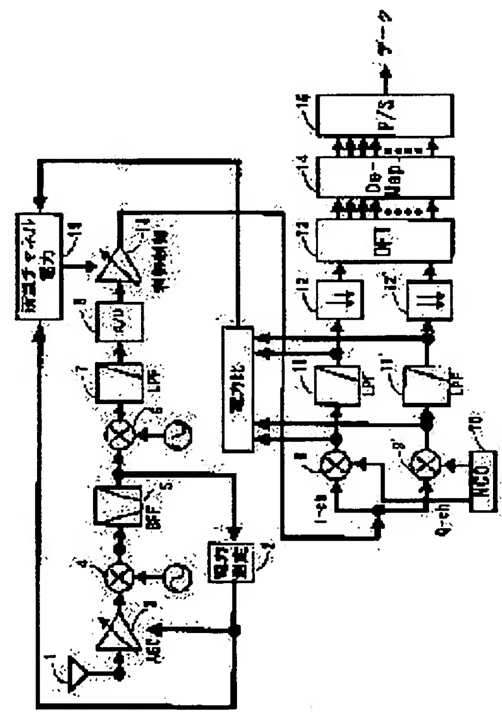
(54) OFDM SIGNAL RECEIVER

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain satisfactory reception characteristics, even when an adjacent channel exists near a desired channel in an OFDM transmission system.

SOLUTION: Power of only the desired channel is obtained, and a gain control means 18 is controlled so as not to amplify the power when it is large and so as to amplify the power, when the power of the desired channel is small by a power of desired channel detecting means 19. The desired channel detecting means 19 has a method for measuring band pass filter output of a narrow band. Other than this method, the ratio between input signal power and output signal power to/from a digital filter for removing loop back components after digital quadrature modulation can be obtained, when the ratio of output power to input power is larger than predetermined ratio between an input signal and an output signal when no channel interference exists, power for interfering the adjacent channel is regarded as large, the power of only the desired channel is regarded as being small, and the gain control means 18 is controlled so as to amplify the power of the input signal of a discrete Fourier transform



circuit as well.

LEGAL STATUS

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block circuit diagram showing the configuration of the OFDM signal receiver in the gestalt of operation of the first of this invention
[Drawing 2] The block circuit diagram showing a part of configuration of the OFDM signal receiver in the gestalt of operation of the second of this invention
[Drawing 3] The block circuit diagram showing the configuration of the OFDM signal receiver in the gestalt of operation of the third of this invention
[Drawing 4] The block circuit diagram showing the configuration of the OFDM signal receiver in the gestalt of operation of the fourth of this invention
[Drawing 5] The block circuit diagram showing a part of configuration of the OFDM signal receiver in the gestalt of operation of the fifth of this invention
[Drawing 6] The block circuit diagram showing a part of configuration of the OFDM signal receiver in the gestalt of operation of the sixth of this invention
[Drawing 7] The block circuit diagram showing a part of configuration of the OFDM signal receiver in the gestalt of operation of the seventh of this invention
[Drawing 8] The block circuit diagram showing a part of configuration of the OFDM signal receiver in the gestalt of operation of the eighth of this invention
[Drawing 9] The block circuit diagram showing the configuration of the OFDM signal receiver in the gestalt of operation of the ninth of this invention
[Drawing 10] The block circuit diagram showing the configuration of the OFDM signal receiver in the gestalt of operation of the tenth of this invention
[Drawing 11] The block circuit diagram showing the configuration of the OFDM signal receiver in the gestalt of operation of the eleventh of this invention
[Drawing 12] The block circuit diagram showing the configuration of a different OFDM signal receiver from drawing 11 in the gestalt of operation of the eleventh of this invention
[Drawing 13] The block circuit diagram showing the configuration of the OFDM signal receiver in the gestalt of operation of the twelfth of this invention
[Drawing 14] The block circuit diagram showing the configuration of a different OFDM signal receiver from drawing 13 in the gestalt of operation of the twelfth of this invention
[Drawing 15] The block circuit diagram showing the configuration of the OFDM signal receiver in the gestalt of operation of the thirteenth of this invention
[Drawing 16] Drawing having shown an example of the frequency spectrum of the DAB signal after a digital rectangular cross recovery in case an adjacent channel exists
[Drawing 17] Drawing in which having gone away six steps of addition number of stageses, and having shown the frequency characteristics of a mold filter
[Drawing 18] Drawing which the frequency spectrum of the DAB signal after passing the comb mold filter of the frequency characteristics of drawing 17 illustrated one time when an adjacent channel existed

[Drawing 19] The block circuit diagram showing a part of configuration of the OFDM signal receiver in the gestalt of operation of the 14th of this invention
[Drawing 20] The mimetic diagram showing the frequency characteristics of the digital low pass filter which makes the signal band decreased with a comb mold filter amplify
[Drawing 21] The block circuit diagram showing a part of configuration of the OFDM signal receiver in the gestalt of operation of the 15th of this invention
[Drawing 22] The block circuit diagram showing the configuration of the conventional OFDM signal receiver
[Description of Notations]
1 Receiving Antenna
2 Band-pass Filter Output Power Test Section
3 Automatic Gain Control Circuit
4 Frequency Converter
5 Band-pass Filter (BPF)
6 Frequency Converter
7 Low Pass Filter (LPF)
8 Analog / Digital Converter
9 Digital Multiplier
9' Digital multiplier
10 Numerical-Control Oscillator (NCO)
11 Digital Low Pass Filter
11' Digital multiplier
12 Infanticide Machine
12' Infanticide machine
13 Discrete Fourier Transform Machine (DFT:Discrete Fourier Transform)
14 Demapping Machine
15 Parallel/Serial (P/S)
16 Narrow-band Band-pass Filter
17 Power Test Section
18 Gain Control Means
19 Request Channel Power Detection Means
20 Adjacent Channel Power Detection Means
21 Request Channel Power Detection Means
22 Power Ratio Operation Means
23 A Means to Detect Digital Low Pass Filter 11 and Power in Preceding Paragraph of 11'
24 A Means to Detect Digital Low Pass Filter 11 and Power in Latter Part of 11'
25 A Means to Obtain Power Ratio in Digital Low Pass Filter 11, and Preceding Paragraph and Latter Part of 11'
26 A Means to Obtain Digital Low Pass Filter 11 and Absolute Value Sum of Amplitude in Preceding Paragraph of 11'
27 A Means to Obtain Digital Low Pass Filter 11 and Absolute Value Sum of Amplitude in Latter Part of 11'
28 A Means to Obtain Ratio in Digital Low Pass Filter 11, and Preceding Paragraph and Latter Part of 11'
29 A Means to Detect Power of Request Channel Band
30 A Means to Detect Power of Adjacent Channel Band
31 A Means to Obtain Power Ratio
32 A Means to Detect Absolute Value Sum of Amplitude in Request Channel Band
33 A Means to Detect Absolute Value Sum of Amplitude of Adjacent Channel Band
34 A Means to Obtain Ratio of Absolute Value Sum
35 A Means to Detect Power of Specific Frequency

36 A Means to Detect Absolute Value of Amplitude in Specific Frequency
37 Digital Low Pass Filter 11, a Means to Ask for Ratio of Input of 11', and Output
38 A Means to Ask for Adjacent Channel Component in Output of Discrete Fourier Transform Machine 13
39 A Means to Determine Control Gain Based on Result Obtained from Means of 37, and Means of 38
40 Gain Control Means
41 41' Gain control means
42 42' Comb mold filter
43 43' Digital low pass filter
44 44' Digital low pass filter which makes the signal band decreased with a comb mold filter amplify
45 45' Switch

[Translation done.]

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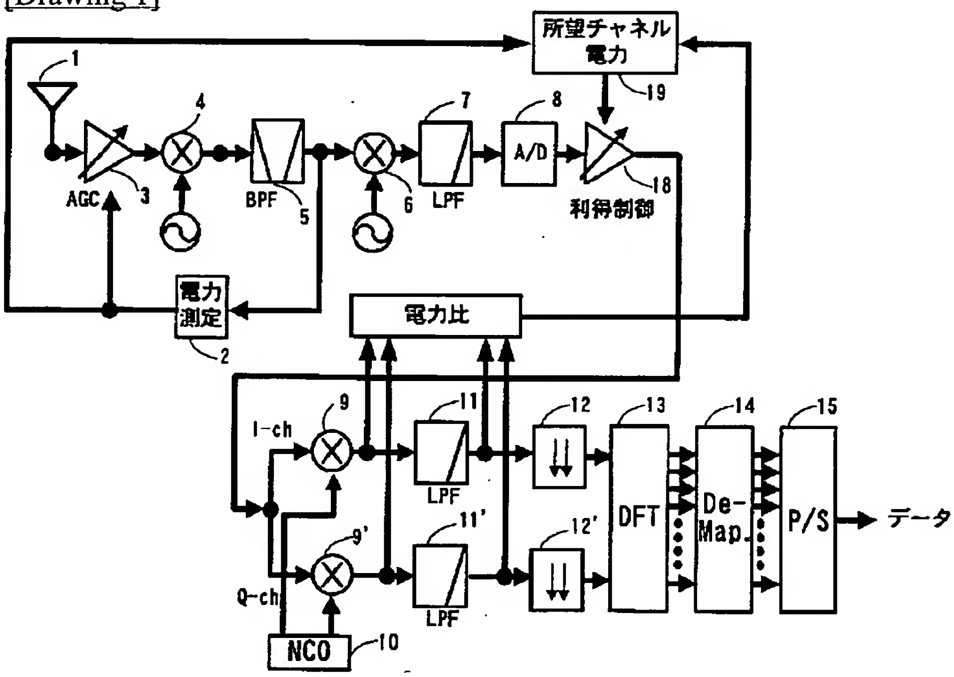
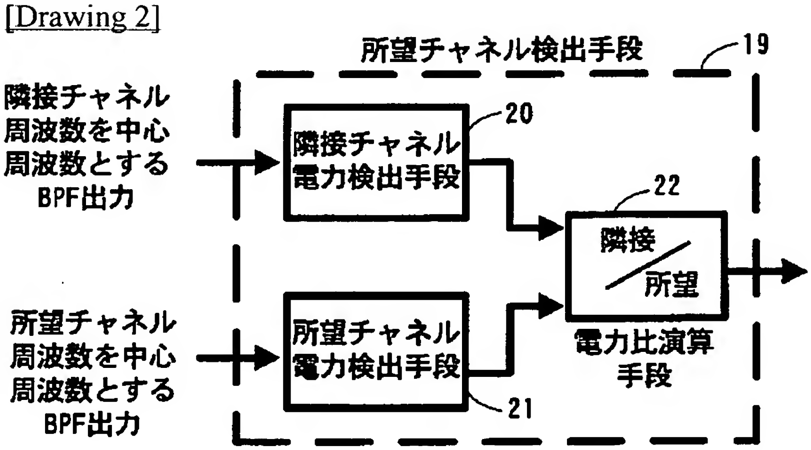
DRAWINGS

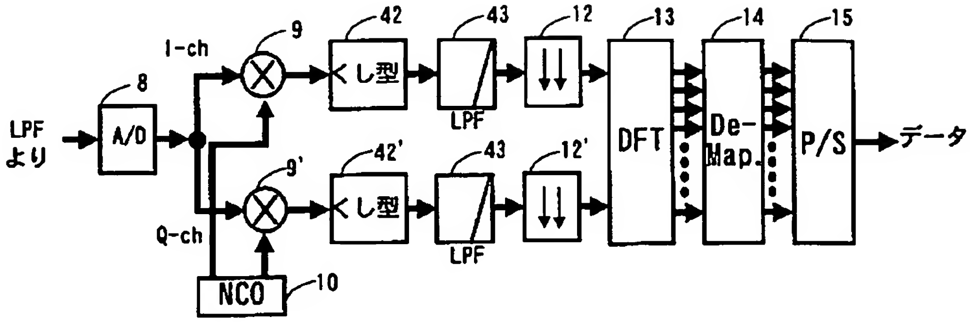
[Drawing 1]



[Drawing 2]



[Drawing 15]



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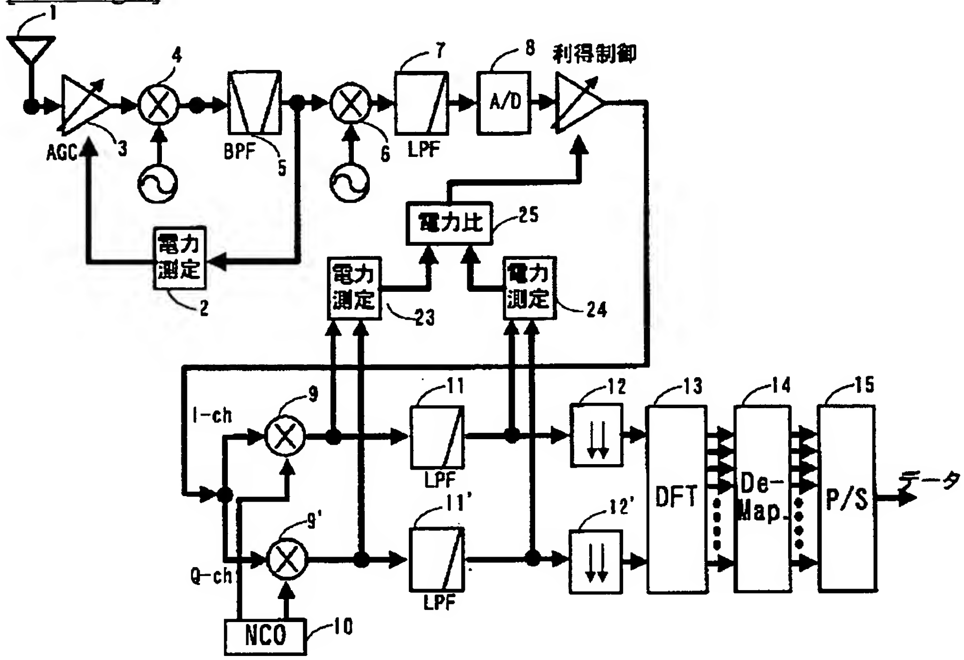

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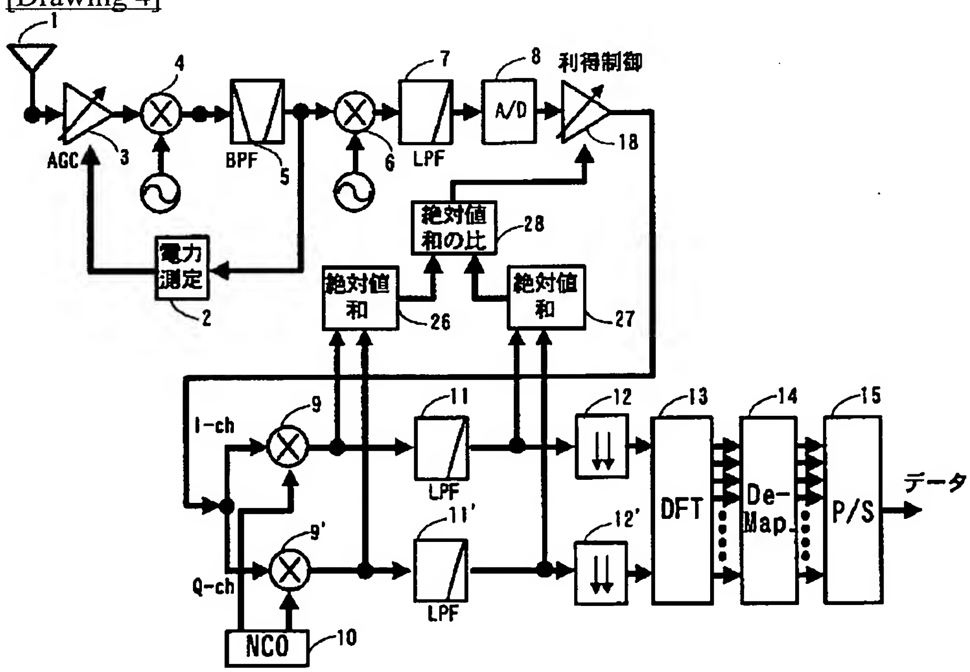

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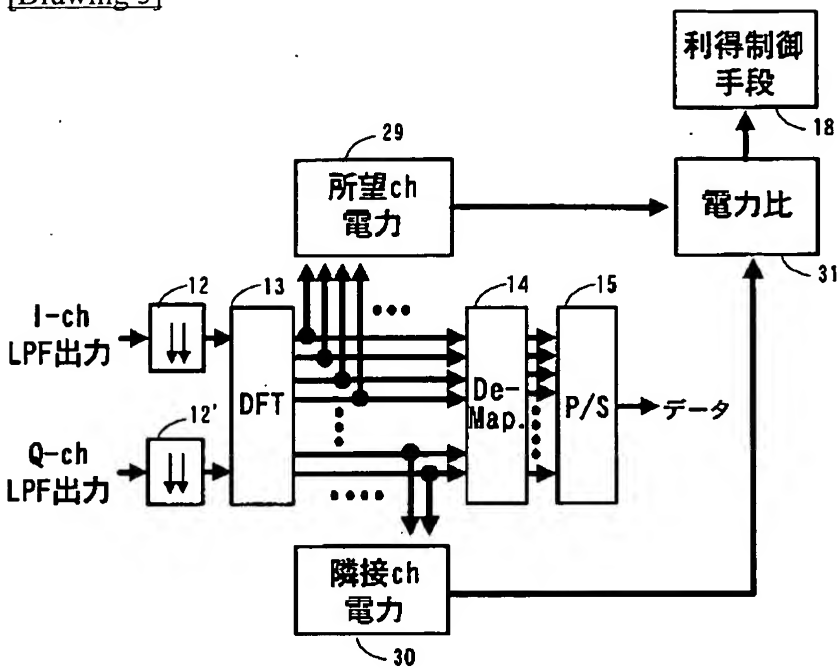

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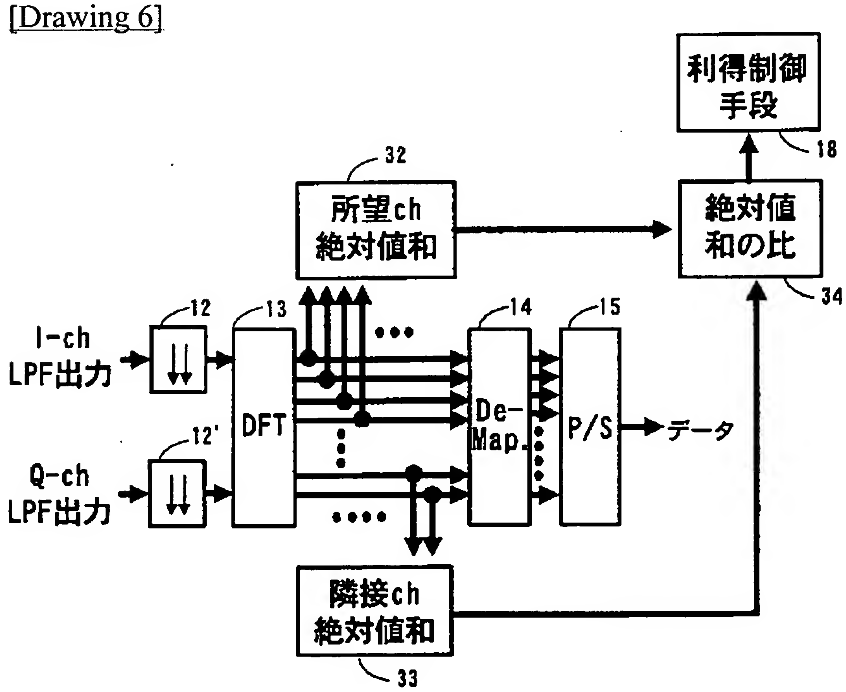

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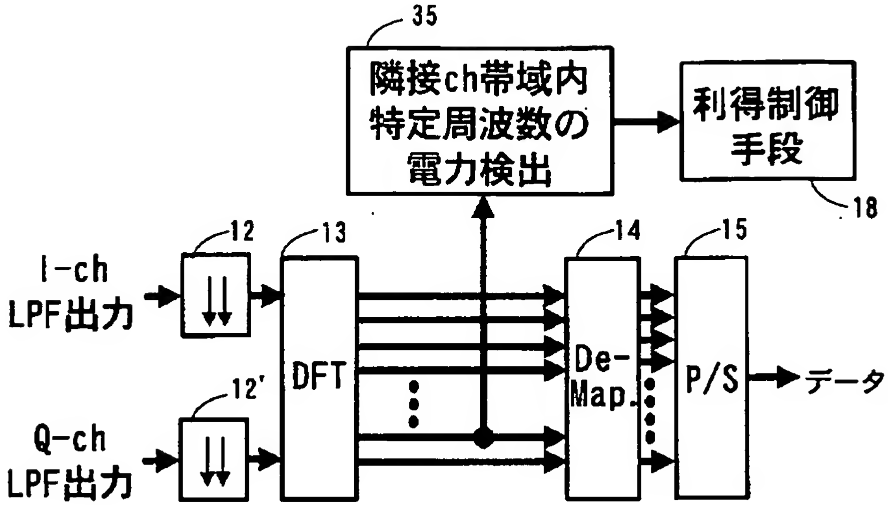

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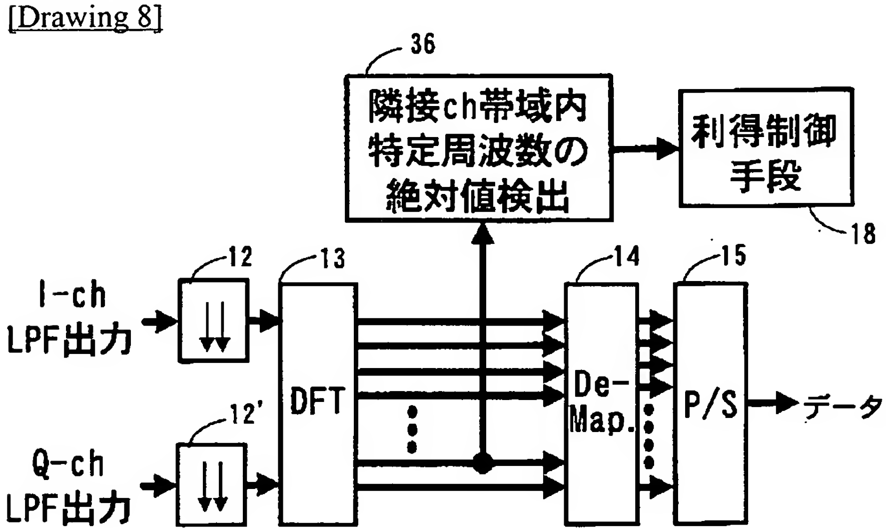

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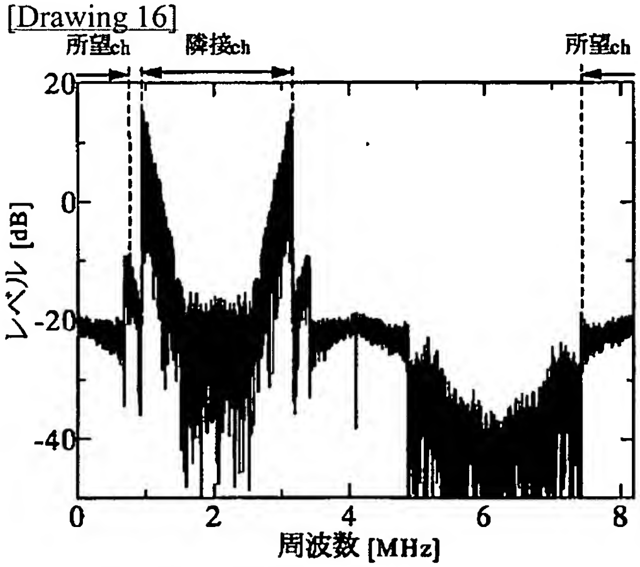

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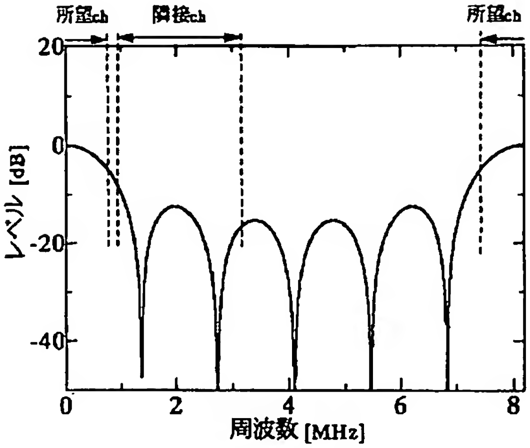

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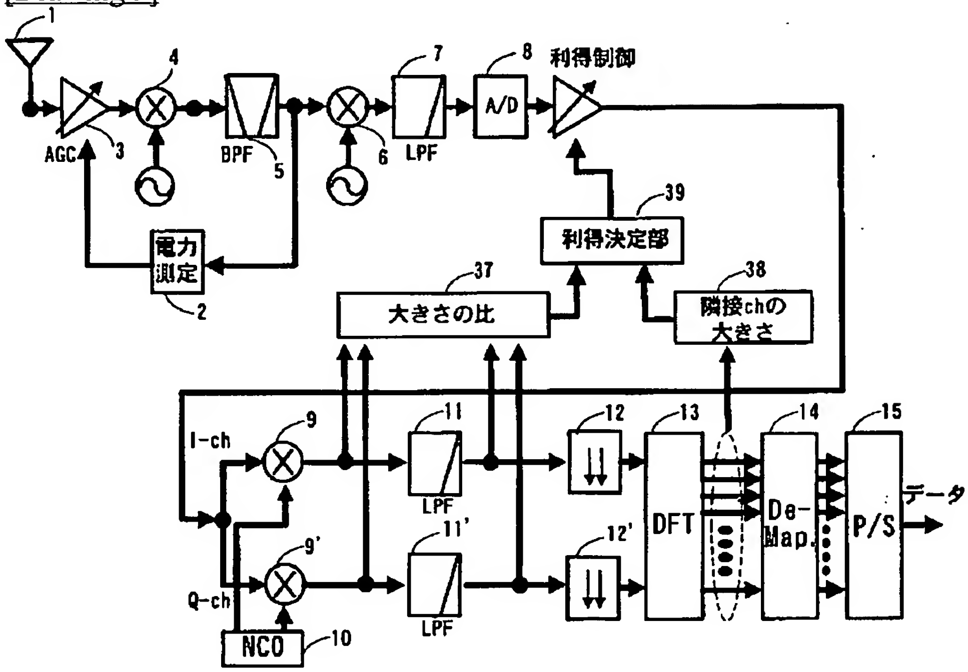

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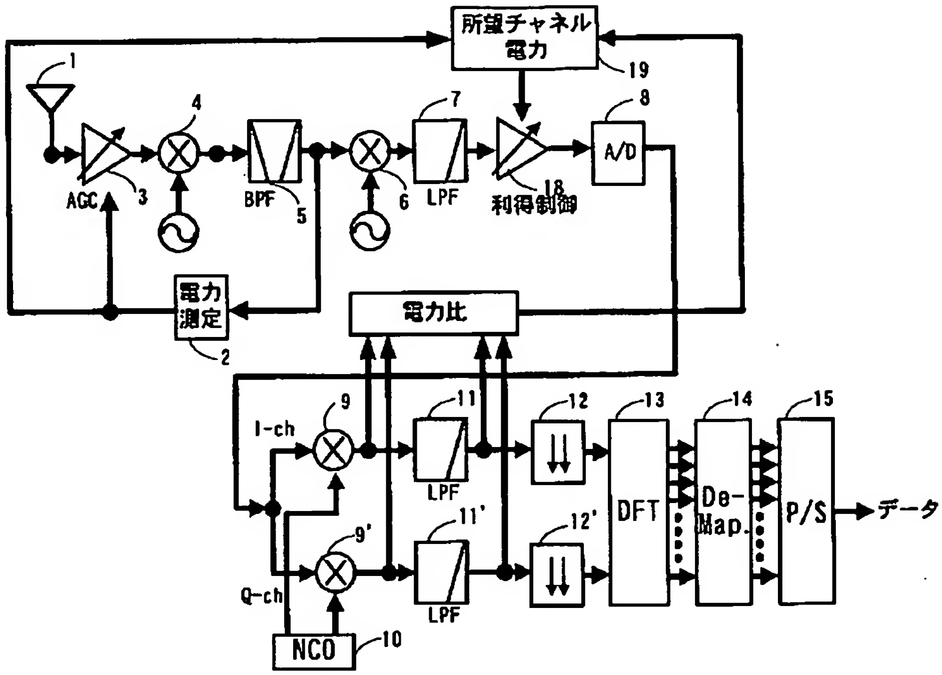

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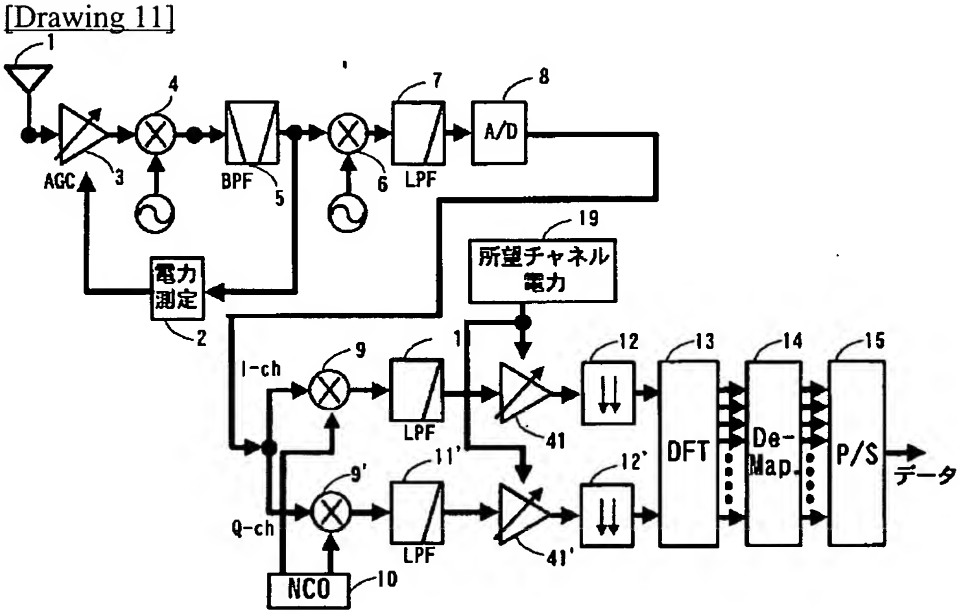

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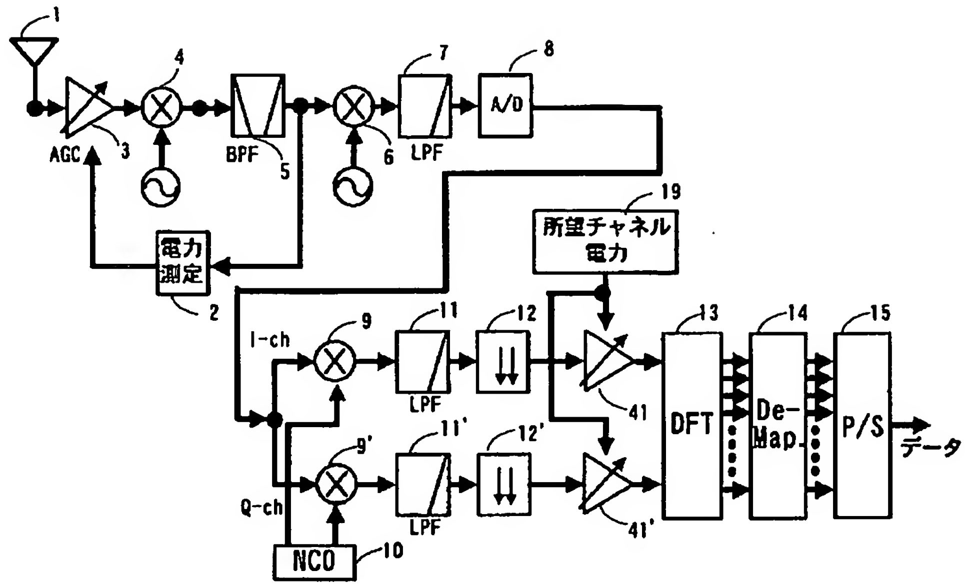

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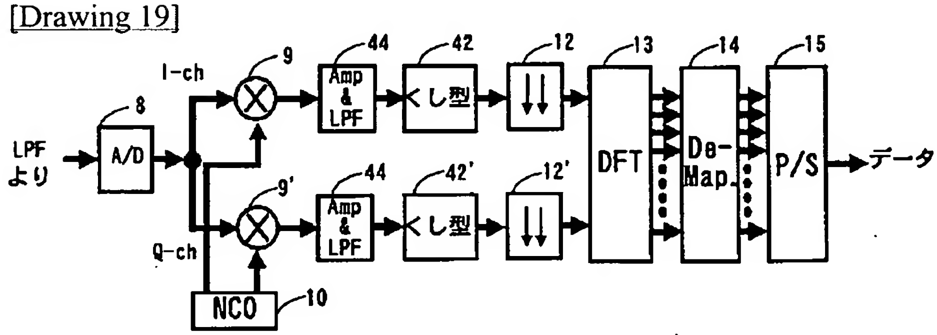

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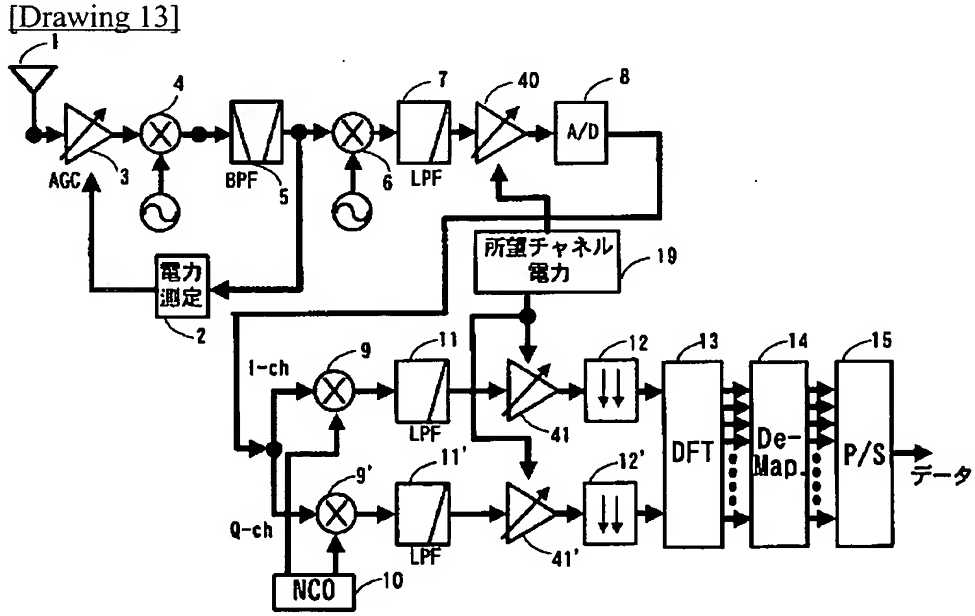

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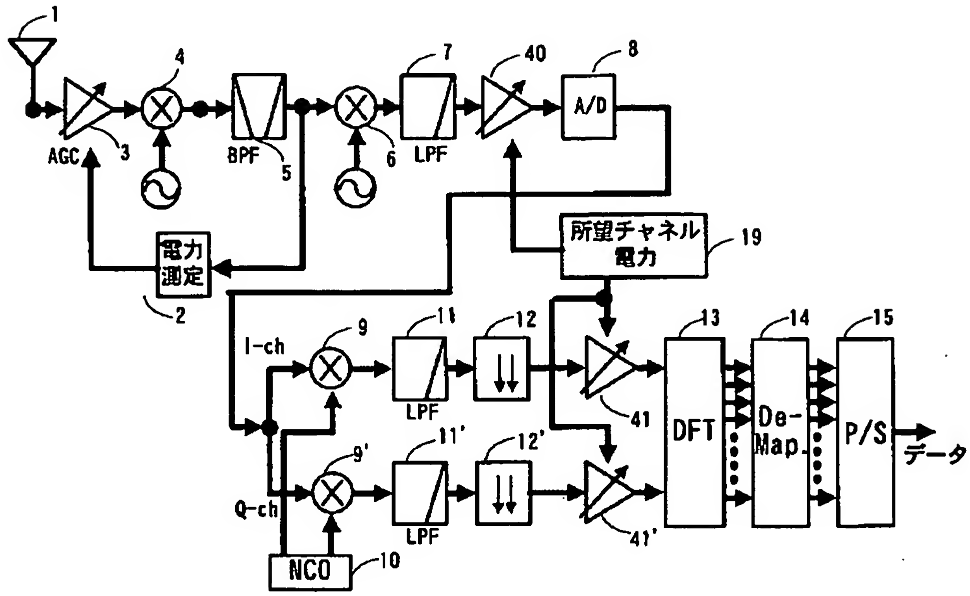

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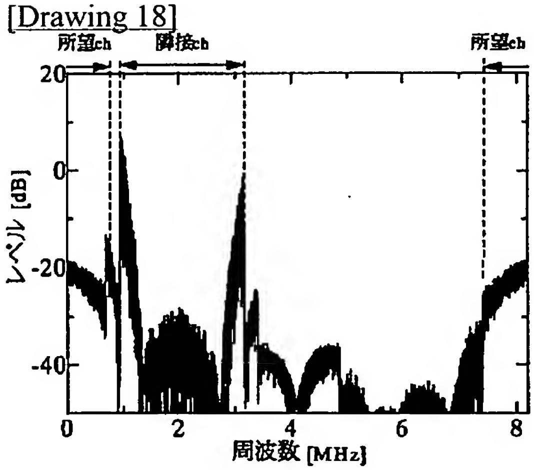
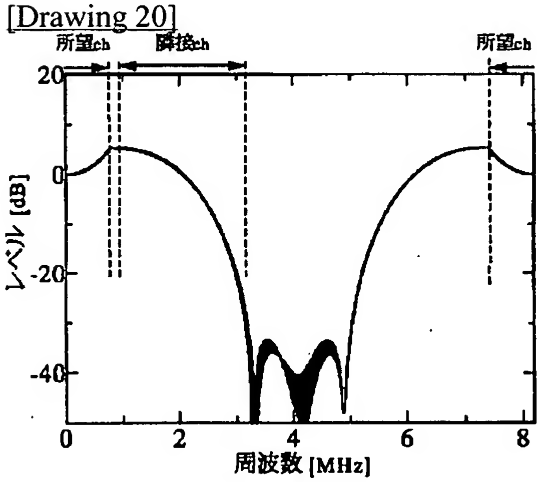
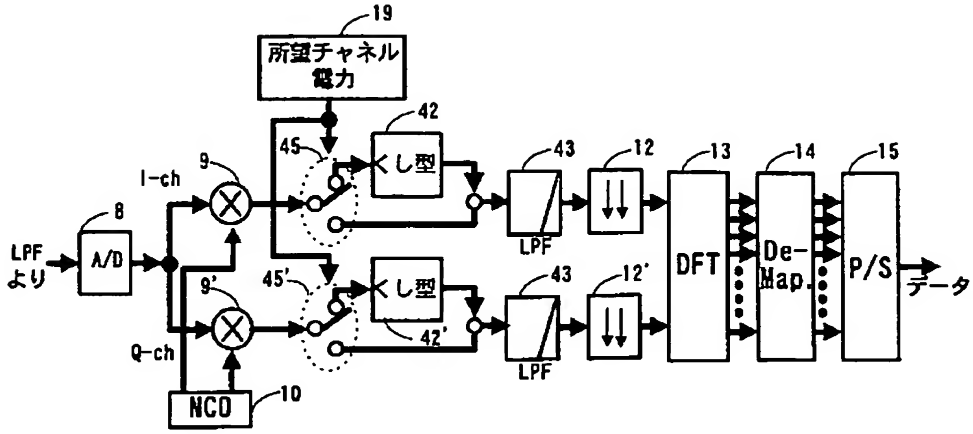


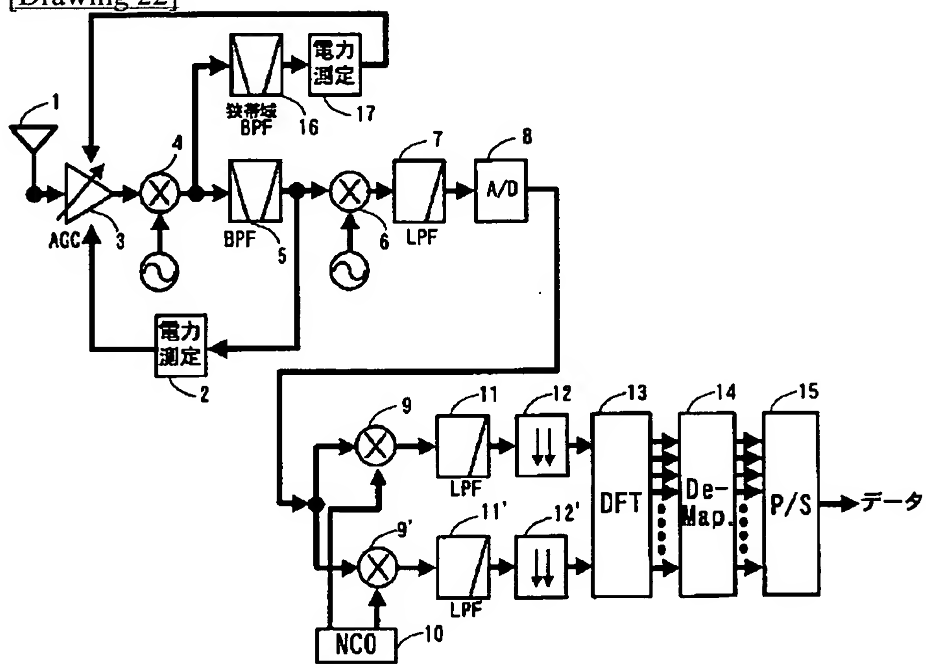
[Drawing 20]



[Drawing 21]



[Drawing 22]



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Line type modulation of each subcarrier is carried out, and this invention relates to the receiving set of the signal by which the orthogonal frequency division multiplex (OFDM) was carried out.
[0002]
[Description of the Prior Art] When the radio frequency channel (the following, adjacent channel) which very large power adjoins compared with a request channel existed near the desired radio frequency channel (henceforth, request channel) conventionally, sufficient receiving sensibility was not obtained only by using the filter (for example, a surface acoustic filter: SAW filter) which has a steep barrier property in an intermediate frequency band.
[0003] Like especially digital voice broadcast (DAB:Digital Audio Broadcasting), when transmitted from the location where each channel is separate, the situation that the power of an adjacent channel becomes large [dozens of dB] rather than a request channel occurs by fluctuation of the wireless propagation path by phasing at the time of migration reception.
[0004] Since the power of a request channel is generally changed when an adjacent channel does not exist at the time of migration reception, automatic gain control (AGC:Auto Gain Control) is performed.
[0005] Since this automatic gain control is controlled based on the filter output power in an intermediate frequency band, when a very big adjacent channel exists near the request channel, with a filter, control according to power change of an adjacent channel will be performed without the ability fully oppressing an adjacent channel, the signal of a request channel will be oppressed, and receiving sensibility deteriorates.
[0006] As one of the approaches of solving this problem, the band-pass filter (BPF:Band Pass Filter) of a narrow-band is independently prepared in the band of a request channel like JP,5-75489,A, and although the method of performing AGC which made effect of an adjacent channel small is learned, since an additional analog circuit is needed, it is not suitable for a miniaturization.
[0007] Furthermore, since it is the band-pass filter of a narrow-band, when a DIP arises in the band of a narrow-band passage filter by frequency selective phasing etc., it will be observed as signal power declined greatly, and incorrect ****** control is performed, and there is a fault that receiving sensibility will deteriorate greatly.
[0008] The configuration of the conventional OFDM signal receiver is shown in drawing 22 , and the signal received with the receiving antenna 1 serves as almost fixed power by the automatic gain control circuit 3 currently controlled by the band-pass filter output power test section 2. Then, a down convert is carried out by the frequency converter 4 at an intermediate frequency band, and the component outside a request channel band is oppressed with a band-pass filter (BPF) 5.
[0009] An image is removed by the low pass filter (LPF) 7 for removing the image produced by frequency conversion after a down convert is furthermore carried out by the frequency converter 6 at a low-pass frequency band.

[0010] Next, after being digitized by an analog / digital transducer 8, an advantage is taken with the sine wave and cosine wave which are outputted from the numerical-control oscillator (NCO:Numerically Controlled Oscillator) 10 in a digital multiplier 9 and 9', and a rectangular recovery is carried out.
[0011] Then, a component is removed by return, and in the digital low pass filter 11 and 11', since [which is doubled with the operation speed of the latter discrete Fourier transform machine 13] it was generated by A/D conversion, infanticide is performed in the infanticide machine 12 and 12'. After the signal by which discrete Fourier transform was carried out is demapped with the demapping vessel 14 by the latter discrete Fourier transform machine 13, parallel/serial conversion of it is carried out in the parallel/serial-conversion machine 15 by it, and data are outputted with it.
[0012] In addition to the above-mentioned configuration, in an intermediate frequency band, it has the narrow-band band-pass filter 16, the power test section 17 is in the latter part, and an automatic gain control circuit 3 is controlled by the approach using the additional circuit known conventionally based on the magnitude of the power in the request channel band obtained by the power test section 17.
[0013]
[Problem(s) to be Solved by the Invention] In case an OFDM method signal is received, when an adjacent channel exists near the request channel, it aims at maintaining good receiving sensibility with a simple configuration.
[0014]
[Means for Solving the Problem] In order to solve this technical problem, when an adjacent channel exists near the request channel, this invention is controlling the discrete Fourier transform (DFT) circuit input signal power according to the magnitude of the power of only a request channel so that it may not be influenced by the adjacent channel, and prevents burying the overflow at the time of the fixed point arithmetic in the discrete Fourier transform circuit, and a request signal in a quantizing noise.
[0015]
[Embodiment of the Invention] The orthogonal frequency division multiplex (OFDM) transmission system with which line type modulation of each subcarrier was carried out has invention of this invention according to claim 1. When an adjacent channel exists near the request channel, the power of only a request channel is measured so that it may not be influenced by the power by the adjacent channel. When the power of only a request channel is small, the discrete Fourier transform (DFT) circuit input signal power is enlarged. When the power of only a request channel is large, the discrete Fourier transform (DFT) circuit input signal power is made small. It prevents burying the overflow at the time of the fixed point arithmetic in the discrete Fourier transform circuit inside a receiver, and a request signal in a quantizing noise, and has an operation of raising the receiving engine performance. The power measuring method of only a request channel has the approach of measuring the band-pass filter output of a narrow-band like a Prior art.
[0016] In addition, when larger than the ratio of an input signal and an output signal in case there is no adjacent channel interference for which asked for the ratio of the input signal power to the digital filter for clinch component removal after a digital rectangular cross recovery and output signal power, and the ratio of output power to input power asked beforehand, adjacent-channel-interference power is large and it is also possible to use the approach of controlling to consider that the power of only a request channel is small and to enlarge the discrete Fourier transform circuit input signal power.
[0017] Moreover, although the approach of carrying out gain control in analog like a Prior art may be used for control of the discrete Fourier transform circuit input signal power, in order to prevent property degradation by environmental variations, such as temperature at the time of reception actuation, the approach of controlling the signal after an AD translation in digital one is suitable.
[0018] In the OFDM signal receiver which indicated invention according to claim 2 to claim 1 control of the discrete Fourier transform circuit (DFT) input signal power It is a thing about the OFDM signal receiver characterized by making small the discrete Fourier transform circuit input signal power when the ratio of the adjacent channel signal power to request channel signaling power is large according to the ratio of request channel signaling power and adjacent channel signal power. Since a DIP produces an adjacent channel as well as a request channel by frequency selective phasing when a DIP arises in a

signal band by frequency selective phasing, Since the phenomenon in which request channel power is measured by DIP as a value smaller than original like [in the case of measuring only request channel power] does not arise, It becomes possible to control the discrete Fourier transform circuit input signal power on suitable level, and has an operation that degradation can maintain the receiving engine performance few while it has been high.

[0019] in the OFDM signal receiver indicated to claim 1 , since the degree of change of the discrete fourier circuit (DFT) input signal power do not need an additional analog circuit about the OFDM signal receiver characterize by having respond to the ratio of the input power to the digital filter for clinch component removal after a digital rectangular cross recovery , and output power , invention according to claim 3 have an operation that a receiver can be miniaturize .

[0020] In the OFDM signal receiver which indicated invention according to claim 4 to claim 1 It is a thing about the OFDM signal receiver with which the degree of change of the discrete fourier circuit (DFT) input signal power is characterized by having responded to the ratio of the absolute value sum of the input signal to the digital filter for clinch component removal after a digital rectangular cross recovery, and the absolute value sum of an output signal. Since there is no multiply operation for obtaining power, the amount of operations can be reduced, and it has an operation that a miniaturization and low-power-izing of a receiver can be attained.

[0021] In the OFDM signal receiver which indicated invention according to claim 5 to claim 2, since the ratio of request channel signaling power and adjacent channel signal power uses the indispensable discrete Fourier transform machine output for the OFDM signal receiver about the OFDM signal receiver characterized by asking from the discrete Fourier transform circuit output signal, it has an operation that there are few additional circuits and they can miniaturize a receiver. If the output signal of the discrete Fourier transform circuit is observed, when it is easy to investigate each power of a request channel and an adjacent channel and the ratio of adjacent channel power to request channel power is large, it will control to make small the input signal to the discrete Fourier transform circuit.

[0022] In the OFDM signal receiver which indicated invention according to claim 6 to claim 1 It is a thing about the OFDM signal receiver characterized by the degree of change of the discrete fourier circuit (DFT) input signal power having responded to the ratio of the absolute value sum of the amplitude of a request channel band and the absolute value sum of the amplitude of an adjacent channel band in the discrete Fourier transform circuit output. It is not necessary to find power, the amount of operations can be reduced, and it has an operation that a miniaturization and low-power-izing of a receiver can be attained.

[0023] In the OFDM signal receiver which indicated invention according to claim 7 to claim 5 the ratio of request channel signaling power and adjacent channel signal power It is a thing about the OFDM signal receiver characterized by what is guessed from the power of the specific frequency in the adjacent channel band after discrete Fourier transform. It is not necessary to find the power of the whole frequency with which an adjacent channel exists, the amount of operations can be reduced, and it has an operation that a miniaturization and low-power-izing of a receiver can be attained.

[0024] It is suitable, if the frequency band where adjacent-channel-interference power should become large most beforehand is investigated in consideration of the frequency characteristics (barrier property) of the channel filter in the intermediate frequency band of a receiver, and the digital filter for clinch component removal after a digital direct recovery and it guesses from the power of only the frequency band, when the frequency in which an adjacent channel exists especially is known.

[0025] In the OFDM signal receiver which indicated invention according to claim 8 to claim 1 In not finding power about the OFDM signal receiver characterized by the degree of change of the discrete fourier circuit (DFT) input signal power having responded to the magnitude of the absolute value sum of the amplitude in the specific frequency in the adjacent channel band after discrete Fourier transform, It is not necessary to ask for the sum of the whole frequency in which an adjacent channel exists, the amount of operations can be reduced, and it has an operation that a miniaturization and low-power-izing of a receiver can be attained.

[0026] It is suitable if adjacent-channel-interference power controls most this invention as well as the

gestalt of the operation in invention according to claim 7 from the absolute value sum of the amplitude of only the frequency band which becomes large.
[0027] Invention according to claim 9 has an operation that the receiving engine performance increases by more flexible control being attained, in the OFDM signal receiver indicated to claim 1 about the OFDM signal receiver characterized by what it opts for when the degree of change of the discrete fourier circuit input signal power combines the approach indicated to claim 2 - claim 8.
[0028] In the OFDM signal receiver which indicated invention according to claim 10 to claim 1 - claim 9, since the input level in consideration of the dynamic range of adjacent channel power, and an analog / digital converter can be set up about the OFDM signal receiver characterized by realizing change of the discrete fourier circuit input signal power by changing the magnitude of the input signal to an analog / digital converter, it has an operation that the receiving engine performance increases.
[0029] In the OFDM signal receiver which indicated invention according to claim 11 to claim 1 - claim 9 change of the discrete fourier circuit input signal power In order to change level in digital one about the OFDM signal receiver characterized by realizing by changing the digital filter output signal for clinch component removal after a digital rectangular cross recovery, It has the operation which is small, does not have secular change and does not have degradation by change of operating temperature etc. that become controllable and the receiving engine performance increases.
[0030] Furthermore, since it becomes possible to input into a digital filter the signal of the correct level beforehand set that the effect by the overflow, rounding error, and quantization error at the time of an operation decreases most, it has an operation that the receiving engine performance increases.
[0031] In the OFDM signal receiver which indicated invention according to claim 12 to claim 1 - claim 9 change of the discrete fourier circuit input signal power It is a thing about the OFDM signal receiver characterized by realizing by combining claim 10 and claim 11. It becomes controllable [in consideration of both the dynamic range of an analog / digital transducer, and a digital filter, and the optimal level of the discrete Fourier transform circuit], and has an operation that the receiving engine performance increases more.
[0032] That is, it is also possible to prevent enlarging the input to an analog / digital transducer, when an adjacent channel exists, and burying a request channel in a quantization error or the rounding error at the time of fixed point arithmetic, and for the input to the discrete Fourier transform circuit to make it small, and to prevent the overflow at the time of an operation.
[0033] In the system by which it is assumed that the orthogonal frequency division multiplex (OFDM) transmission system with which line type modulation of each subcarrier was carried out has invention according to claim 13, and an adjacent channel exists near the request channel It is a thing about the OFDM signal receiver characterized by being small-scale to the digital filter for clinch component removal after a digital rectangular cross recovery, and using the loose filter of a barrier property, using a comb mold filter in the object for adjacent channel signal removal. The circuit scales of a digital filter can be reduced and it has an operation that a miniaturization and low-power-izing of a receiver can be attained.
[0034] It becomes possible [since a comb mold filter does not need to multiply by the tap multiplier, it can make a circuit scale small, and] to reduce effectively the frequency components which influence greatly for the maximum and the receiving engine performance of the adjacent channel power assumed, if an addition number of stages is chosen appropriately.
[0035] It is suitable if the frequency component which influences the receiving engine performance greatly here uses the comb mold filter of the addition number of stages which can reduce effectively the frequency for which it could ask for the frequency of this adjacent channel power component beforehand when the frequency in which it is the adjacent channel power component which laps with a signal band, and an adjacent channel exists with the infanticide vessel behind a digital filter was known, and it asked.
[0036] In the OFDM signal receiver indicated to claim 13, invention according to claim 14 can reduce the quantizing noise of the subcarrier of the signal band decreased with a comb mold filter about the OFDM signal receiver characterized by making only the signal band decreased with a comb mold filter

amplify with the digital filter for component removal by return, and has an operation that the receiving engine performance increases.
[0037] Although coincidence will be made to also decrease the power of a signal band since a comb mold filter has the narrow passband, this invention devises the frequency characteristics of the digital filter for clinch component removal, it is designing so that only the signal band decreased with a comb mold filter may be made to amplify, and the reduction of the quantizing noise made by attenuation of it is attained.
[0038] In the OFDM signal receiver indicated to claim 13 or claim 14, invention according to claim 15 has an operation that power-saving can be attained in order not to use an unnecessary comb mold filter about the OFDM receiver characterized by not using a comb mold filter when an adjacent channel does not exist, or when adjacent channel power is sufficiently small, when there is no effect of an adjacent channel.
[0039] In the OFDM signal receiver which indicated invention according to claim 16 to claim 13 It is a thing about the OFDM receiver characterized by using an approach according to claim 2 to 9 as an approach of determining whether use a comb mold filter. Also when a DIP arises in a signal band by frequency selective phasing etc., it can ask for the power ratio of a request channel and an adjacent channel correctly, and it has the operation without incorrect actuation that it becomes controllable and the high receiving engine performance can be maintained.
[0040] Invention according to claim 17 has an operation that quality communication system can be built, about the communication system characterized by using the receiving set indicated to claim 1 - claim 16.

[0041] Hereafter, the gestalt of operation of this invention is explained using drawing 21 from drawing 1 .
[0042] Drawing 1 shows the gestalt 1 of the operation which uses this invention, and sets it to drawing 1 . (Gestalt 1 of operation) The OFDM signal receiver of this invention The gain control means 18 is formed in the latter part of the analog / digital converter 8 in the conventional OFDM signal receiver. In addition, a receiving antenna 1, the band-pass filter output power test section 2, an automatic gain control circuit 3, a frequency converter 4, a band-pass filter (BPF) 5, a frequency converter 6, a low pass filter (LPF) 7, the analog / digital transducer 8, a digital multiplier 9, and 9', It consists of the numerical-control oscillator (NCO) 10, a digital low pass filter 11 and 11', and the infanticide machine 12 and 12', the discrete Fourier transform machine 13, the demapping machine 14 and the parallel/serial-conversion machine 15.
[0043] The request channel power detection means 19 obtains the power of only a request channel, and when this power is large, when request channel power is small, it controls the gain control means 18 to make it amplify not to amplify.
[0044] The request channel detection means 19 has the approach of measuring the band-pass filter output of a narrow-band like a Prior art. In addition, when larger than the ratio of an input signal and an output signal in case there is no adjacent channel interference for which asked for the ratio of the input signal power to the digital filter for clinch component removal after a digital rectangular cross recovery and output signal power, and the ratio of output power to input power asked beforehand, adjacent-channel-interference power is large and it is also possible to use the approach of controlling to consider that the power of only a request channel is small and to enlarge the discrete Fourier transform circuit input signal power.
[0045] (Gestalt 2 of operation) Drawing 2 shows the gestalt 2 of the operation which uses this invention, and in drawing 2 , the OFDM signal receiver of this invention materializes the request channel detection means 19 in drawing 1 , and consists of an adjacent channel power detection means 20, a request channel power detection means 21, and a power ratio operation means 22. The adjacent channel power detection means 20 obtains the band-pass filter (BPF) output of the narrow-band which makes center frequency the frequency in which an adjacent channel exists like a Prior art, and detects power, and the request channel detection means 21 obtains the band-pass filter (BPF) output of the narrow-band which makes center frequency the frequency in which a request channel exists, and detects power.

[0046] It is also possible to detect the power of an adjacent channel and a request channel from the discrete Fourier transform circuit output later mentioned with the gestalt 5 of operation as other means. The power ratio operation means 22 asks for the ratio of each channel power obtained from the adjacent channel power detection means 20 and the request channel power detection means 21, and controls the gain control means 18 in drawing 1 according to the magnitude of this power ratio. It controls in the direction which will make signal power amplify if the ratio of adjacent channel power to a request channel is large, and controls not to amplify, if small.
[0047] Drawing 3 shows the gestalt 3 of the operation which uses this invention, and sets it to drawing 3 . (Gestalt 3 of operation) The OFDM signal receiver of this invention The channel which materializes the adjacent channel detection means in drawing 1 , and intersects perpendicularly mutually (I-ch:In-PhaseChannel) a means 23 to detect the power in the digital low pass filter 11 of Q-ch:QuadratureChannel, and the preceding paragraph of 11' -- and It consists of a digital low pass filter 11, a means 24 to detect the power in the latter part of 11', and a means 25 to obtain these power ratios.
[0048] Since adjacent channel power is not enough oppressed after digital low pass filter passage when the ratio of adjacent channel power to a request channel is large, the ratio of the value acquired with the power detection means 24 against the value acquired with the power detection means 23 becomes large.
[0049] Then, according to the magnitude of this power ratio, the gain control means 18 in drawing 3 R> 3 is controlled. The ratio of adjacent channel power to this request channel enlarges signal power with the gain control means 18 noting that it calculates the value in case an adjacent channel does not exist beforehand, and an adjacent channel exists, if larger than that value.
[0050] Here, although the power of the channel (I-ch, Q-ch) which intersects perpendicularly mutually in drawing 3 is detected and the gain control means 18 is controlled by the power ratio of the preceding paragraph of a digital low pass filter, and the latter part, the same effectiveness is acquired even if it controls by the power ratio of only one of channels. A circuit scale becomes small and is suitable if the approach of controlling based on the power ratio of only one channel is used.
[0051] Drawing 4 shows the gestalt 4 of the operation which uses this invention, and sets it to drawing 4 . (Gestalt 4 of operation) The OFDM signal receiver of this invention The channel which materializes the adjacent channel detection means in drawing 1 , and intersects perpendicularly mutually (I-ch) Q-ch -- digital one -- a low pass filter -- 11 -- 11 -- ' -- the preceding paragraph -- it can set -- the amplitude -- an absolute value -- the sum -- obtaining -- a means -- 26 -- and -- digital one -- a low pass filter -- 11 -- 11 -- ' -- the latter part -- it can set -- the amplitude -- an absolute value -- the sum -- obtaining -- a means -- 27 -- and -- these -- a ratio -- obtaining -- a means -- 28 -- from -- constituting -- having .
[0052] Since adjacent channel power cannot fully be oppressed after digital low pass filter passage when the rate of adjacent channel power to a request channel is large, the ratio of the value acquired with the absolute value sum detection means 27 against the value acquired with the absolute value sum detection means 26 becomes large. Then, according to the magnitude of the ratio of this absolute value sum, the gain control means 18 in drawing 4 is controlled.
[0053] The ratio of the absolute value sum of an adjacent channel to the absolute value sum of this request channel enlarges signal power with the gain control means 18 noting that it calculates the value in case an adjacent channel does not exist beforehand, and an adjacent channel exists, if larger than that value.
[0054] Here, although the absolute value sum of the channel (I-ch, Q-ch) which intersects perpendicularly mutually in drawing 4 is detected and the gain control means 18 is controlled by the ratio of the absolute value sum of the preceding paragraph of a digital low pass filter, and the latter part, the same effectiveness is acquired even if it controls by the ratio of the absolute value sum of only one of channels. A circuit scale becomes small and is suitable if the approach of controlling based on the ratio of the absolute value sum of only one channel is used.
[0055] (Gestalt 5 of operation) Drawing 5 shows the gestalt 5 of the operation which uses this invention, and in drawing 5 , the OFDM signal receiver of this invention materializes the adjacent channel detection means in drawing 1 , and consists of a means 29 to detect the power of a request channel band in the output of the discrete Fourier transform machine 13, a means 30 to detect the power of an adjacent

channel band, and a means 31 to obtain these power ratios. The gain control means 18 is controlled according to the obtained power ratio.

[0056] Generally, the discrete Fourier transform machine which has the number of frequency divisions of the exponentiation of 2 as a discrete Fourier transform machine 13 is used. The number of subcarriers of the signal inputted into this discrete Fourier transform machine has become less than the number of frequency divisions of this discrete Fourier transform machine. For example, in the case of the mode 1 of DAB (DigitalAudioBroadcasting), the discrete Fourier transform machine with the number of frequency divisions of 2048 (= 211) is usually used to the 1536 subcarrier number of signals.

[0057] Thus, if the discrete Fourier transform machine with more frequency division than the number of subcarriers of a signal is used, when an adjacent channel exists near the request channel, frequency conversion not only of a request channel but a part of adjacent channel band is carried out with the discrete Fourier transform vessel. After frequency conversion, the gestalt of this operation detects the power of an adjacent channel band, and the power of a request channel band, and controls the gain control means 18 based on these power ratios.

[0058] It becomes [to acquire the same effectiveness, even if it asks for one of power ratios, and to make a circuit scale small] possible and is suitable even if it does not use both the real part of the discrete Fourier transform circuit, and imaginary part here, when asking for the power ratio of request channel power and adjacent channel power.

[0059] (Gestalt 6 of operation) Drawing 6 shows the gestalt 6 of the operation which uses this invention, and in drawing 6 , the OFDM signal receiver of this invention materializes the adjacent channel detection means in drawing 1 , and consists of a means 32 to detect the absolute value sum of the amplitude in a request channel band in the output of the discrete Fourier transform machine 13, a means 33 to detect the absolute value sum of the amplitude of an adjacent channel band, and a means 34 to obtain these ratios. The gain control means 18 is controlled according to the magnitude of the obtained absolute value sum.

[0060] It becomes [to acquire the same effectiveness, even if it asks for the ratio of one of the absolute value sums and to make a circuit scale small] possible and is suitable even if it does not use both the real part of the discrete Fourier transform circuit, and imaginary part here, when asking for the ratio of the absolute value sum of the amplitude of a request channel, and the absolute value sum of the amplitude of an adjacent channel.

[0061] (Gestalt 7 of operation) Drawing 7 shows the gestalt 7 of the operation which uses this invention, and in drawing 7 , the OFDM signal receiver of this invention materializes the adjacent channel detection means in drawing 1 , and it uses a means 35 to detect the power of the specific frequency in the adjacent channel band after discrete Fourier transform in the output of the discrete Fourier transform machine 13. The gain control means 18 is controlled according to the magnitude of the power of this specific frequency. When the frequency in which an adjacent channel exists beforehand especially, and the property of the filter (an analog and digital filter) of the preceding paragraph are known, it is suitable, if the frequency band where adjacent channel power should become large most beforehand is investigated and it guesses from the power of only the frequency band.

[0062] It becomes [to acquire the same effectiveness, even if it finds one of power, and to make a circuit scale small here, even if it does not use both the real part of the discrete Fourier transform circuit and imaginary part, when asking for the magnitude of the specific frequency power in an adjacent channel band] possible and is suitable.

[0063] (Gestalt 8 of operation) Drawing 8 shows the gestalt 8 of the operation which uses this invention, and in drawing 8 , the OFDM signal receiver of this invention materializes the adjacent channel detection means in drawing 1 , and it uses a means 36 to detect the absolute value of the amplitude in the specific frequency in the adjacent channel band after discrete Fourier transform in the output of the discrete Fourier transform machine 13. The gain control means 18 is controlled according to the magnitude of this absolute value.

[0064] When the frequency in which an adjacent channel exists beforehand especially, and the property of the filter (an analog and digital filter) of the preceding paragraph are known, it is suitable, if the

frequency band where adjacent channel power should become large most beforehand is investigated and it guesses from the power of only the frequency band.
[0065] It becomes [to acquire the same effectiveness, even if it calculates one of absolute values, and to make a circuit scale small here, even if it does not use both the real part of the discrete Fourier transform circuit, and imaginary part, when asking for the magnitude of the absolute value of the amplitude in an adjacent channel band] possible and is suitable.
[0066] Drawing 9 shows the gestalt 9 of the operation which uses this invention, and sets it to drawing 9 . (Gestalt 9 of operation) The OFDM signal receiver of this invention In the output of a means 37 to materialize the adjacent channel detection means in drawing 1 , and to ask for the ratio of the input of the digital low pass filter 11 and 11', and an output, and the discrete Fourier transform machine 13 It consists of means 39 to determine control gain, based on the result obtained from a means 38 to ask for an adjacent channel component, and the two above-mentioned means.
[0067] Either of the approaches stated to the gestalten 5-8 of the operation as a means 38 to ask for an adjacent channel component in the output of the discrete Fourier transform machine 13 using the approach stated to the gestalt 3 of the operation as a means 37 and the gestalt 4 of operation which ask for the ratio of the input of the digital low pass filter 11 and 11' and an output, or the approach which combined these is used.
[0068] Based on the result obtained from a means 37 to ask for an I/O ratio, and a means 38 to ask for an adjacent channel component, a means 39 to determine control gain presumes the magnitude of an adjacent channel component, and controls a control means 18 based on estimate.
[0069] When it is the result of the result obtained from a means 37 to ask for an I/O ratio, and the result obtained from a means 38 to ask for an adjacent channel component saying both that an adjacent channel exists, it controls to amplify a signal, and if it is made not to make a signal amplify when results differ, it will become possible to make the probability of malfunction low.
[0070] (Gestalt 10 of operation) Drawing 10 shows the gestalt 10 of the operation which uses this invention, and the OFDM signal receiver of this invention consists of a gain control means 40 to change the magnitude of the input signal to an analog / digital transducer 8, and a request channel power detection means 19, in drawing 10 .
[0071] Even if it may exceed a dynamic range somewhat in consideration of the dynamic range of an analog / digital transducer in the gain control means 40 according to the magnitude of the request channel power obtained by the request channel power detection means 19, it controls to amplify signal power, when a request channel is small compared with an adjacent channel.
[0072] (Gestalt 11 of operation) Drawing 11 shows the gestalt 11 of the operation which uses this invention, and the OFDM signal receiver of this invention consists of the gain control means 41 and 41' to which the magnitude of a signal is changed in digital one, and a request channel power detection means 19 in the output of the digital low pass filter 11 and 11' in drawing 11 .
[0073] It controls so that the signal of a request channel is set to level with least degradation in the gain control means 41 and 41' in consideration of overflow of the latter discrete Fourier transform machine 13 or a rounding error according to request channel power with the request channel power detection means 19.
[0074] The request channel power detection means 19 can be used combining either of the gestalten 10 of the gestalt 1 of operation mentioned above - operation, or these.
[0075] Here, the same effectiveness is acquired, even if it thins out the gain control means 41 and 41' like drawing 12 instead of the latter part of a digital low pass filter and arranges in the latter part of a vessel 12 and 12'. Since a working speed can be made later than the latter part of a digital low pass filter when arranging in the latter part of the infanticide machine 12 and 12', it becomes [to make power consumption small] possible and is suitable.
[0076] (Gestalt 12 of operation) drawing 13 -- this invention -- using -- operation -- a gestalt -- 12 -- being shown -- **** -- drawing 12 -- setting -- this invention -- OFDM -- a signal -- a receiver -- an analog -- /-- digital one -- a transducer -- eight -- an input signal -- magnitude -- changing -- making -- gain control -- a means -- 40 -- and -- digital one -- a low pass filter -- 11 -- 11 -- ' -- an output -- setting -

- a signal -- magnitude -- changing -- making -- gain control -- a means -- 41 -- 41 -- ' -- and -- a request -- a channel -- power -- detection -- a means -- 19 -- from -- constituting -- having .
[0077] The request channel power detection means 19 can be used combining either of the gestalten 10 of the gestalt 1 of operation mentioned above - operation, or these.
[0078] According to the magnitude of the request channel power obtained by the request channel detection means 19, both the gain control means 40 of an analog / digital transducer 8 input signal and the digital low pass filter 11, the gain control means 41 of 11' output signal, and 41' are controlled. The gain control means 40 of an analog / digital transducer 8 input signal mainly takes into consideration the dynamic range of an analog / digital transducer. Gain control which has that the maximum amplitude value of an input signal exceeds [little] a dynamic range is performed. The digital low pass filter 11, the gain control means 41 of 11' output signal, and 41' perform gain control so that degradation at the time of restoring to a request channel may mainly be set to the smallest level in consideration of the overflow at the time of the operation in the discrete Fourier transform machine, or the effect of a rounding error.
[0079] Here, like (the gestalt 11 of operation), even if it thins out the gain control means 41 and 41' like drawing 14 instead of the latter part of a digital low pass filter and arranges in the latter part of a vessel 12 and 12', the same effectiveness is acquired. Since a working speed can be made later than the latter part of a digital low pass filter when arranging in the latter part of the infanticide machine 12 and 12', it becomes [to make power consumption small] possible and is suitable.
[0080] (Gestalt 13 of operation) drawing 15 -- this invention -- using -- operation -- a gestalt -- 13 -- being shown -- **** -- drawing 15 -- setting -- this invention -- OFDM -- a signal -- a receiver -- an analog -- /-- digital one -- a transducer -- eight -- a digital multiplier -- nine -- nine -- ' -- and -- numerical control -- an oscillator (NCO) -- ten -- a comb -- a mold -- a filter -- 42 -- 42 -- ' -- and -- digital one -- a low pass filter -- 43 -- 43 -- ' -- infanticide -- a vessel -- 12 -- 12 -- ' -- discrete Fourier transform -- a vessel -- 13 -- demapping -- a vessel -- 14 -- parallel/serial conversion -- a vessel -- 15 -- from -- constituting -- having .
[0081] In the analog low pass filter output which removes the image after a down convert, after an input signal is changed into a digital signal by the analog / digital transducer 8, with a digital multiplier 9, 9', and the numerical-control oscillator (NCO) 10, a digital rectangular cross recovery is carried out and it is divided into I-ch (inphase channel) and Q-ch (rectangular channel). The comb mold filter 42 and 42' realizable in a circuit small-scale as an object for adjacent channel component removal are prepared in the latter part. Next, the digital low pass filter 43 for [component / adjacent channel] clinch component removal in a repressed signal and 43' are used. Then, it doubles with the working speed of the discrete Fourier transform machine 13 by the infanticide machine 12 and 12'.
[0082] Here, if the addition number of stages of a comb mold filter is set up so that a DIP may arise in the frequency in which a big adjacent channel component exists, it can oppress adjacent channel power effectively and is suitable.
[0083] For example, in a DAB (DigitalAudioBroadcasting) receiver, if it makes the addition number of stages of a comb mold filter into six steps in setting the sampling rate of an analog / digital converter 8 to 8.192MHz, adjacent channel power can be oppressed effectively. This situation is shown in drawing 16 -18.
[0084] The frequency spectrum of the DAB signal after a digital rectangular cross recovery is shown in drawing 16 . Conditions assume the transmitting mode 1 of DAB, and center frequency spacing of a request channel and an adjacent channel that the filter which has the barrier property of the general SAW filter as a band-pass filter of an intermediate frequency band is used, when 1.712MHz (guard band 176kHz) and adjacent channel power are larger than a request channel 40dB, they are the preceding paragraph of an analog / digital transducer 8, and adjacent channel power is in them by force as what is oppressed to some extent.
[0085] It is near the request channel that the both sides of an adjacent channel component have become like an angle, and with the band-pass filter, it is a component without oppression ****** and has appeared in both sides for the clinch by the analog / digital conversion. In drawing 1717 , it goes away six steps of addition number of stageses, the frequency characteristics of a mold filter are shown, and the

frequency spectrum of the DAB signal after comb mold filtering is shown in drawing 18 .
[0086] If drawing 16 is compared with drawing 18 , it can check that adjacent channel power can be effectively oppressed with the comb mold filter.
[0087] Drawing 19 shows the gestalt 14 of the operation which uses this invention, and sets it to drawing 19 . (Gestalt 14 of operation) The OFDM signal receiver of this invention an analog / digital transducer 8, a digital multiplier 9, and 9' -- and the digital low pass filter 44 and 44' which make the signal band decreased with the numerical-control oscillator (NCO) 10 and a comb mold filter amplify -- and It consists of the comb mold filter 42, 42' and the infanticide machine 12, 12', a discrete Fourier transform machine 13, a demapping machine 14, and a parallel/serial-conversion machine 15.
[0088] The frequency characteristics of the digital low pass filter 44 and 44' which make the signal band decreased with a comb mold filter amplify are typically shown in drawing 20 . By using the low pass filter shown in drawing 20 , the quantizing noise of the subcarrier of the signal band decreased with a comb mold filter can be reduced.
[0089] It is more suitable to prepare a low pass filter in the preceding paragraph, as here showed the sequence of a low pass filter 44, 44', and the comb mold filter 42 and 42' to drawing 19 in consideration of the rounding error in fixed point arithmetic.
[0090] Drawing 21 shows the gestalt 15 of the operation which uses this invention, and sets it to drawing 21 . (Gestalt 15 of operation) The OFDM signal receiver of this invention an analog / digital transducer 8, a digital multiplier 9, and 9' -- and the numerical-control oscillator (NCO) 10, a switch 45, 45', and the adjacent channel detection means 19 and the comb mold filters 42 and 42 -- ' -- It consists of the digital low pass filter 43, 43' and the infanticide machine 12, 12', a discrete Fourier transform machine 13, a demapping machine 14, and a parallel/serial-conversion machine 15.
[0091] The request channel power detection means 19 can be used combining either of the gestalten 10 of the gestalt 1 of operation mentioned above - operation, or these.
[0092] when a request channel power detection means detects the power of a request channel, consequently it is judged with adjacent channel power being large compared with request channel power, a comb mold filter is passed, and when it does not exist, it is made to pass as it is -- as -- switches 45 and 45 -- ' -- it changes. Since it is not necessary to use an unnecessary comb mold filter when there is no effect of an adjacent channel if it does in this way, power-saving can be attained.
[0093]
[Effect of the Invention] As mentioned above, according to this invention, when an adjacent channel exists near the request channel, by changing the discrete Fourier transform (DFT) circuit input signal power, it can prevent burying the overflow at the time of the fixed point arithmetic in the discrete Fourier transform circuit, and a request signal in a quantizing noise, and the good receiving engine performance can be obtained.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The OFDM signal receiver characterized by making it change so that an interference according the discrete Fourier transform (DFT) circuit input signal power to an adjacent channel may be decreased after A/D conversion when it is in the orthogonal frequency division multiplex (OFDM) transmission system with which line type modulation of each subcarrier was carried out and an adjacent channel exists near the request channel.
[Claim 2] The OFDM signal receiver with which the degree of change of the discrete fourier circuit (DFT) input signal power is characterized by having responded to the ratio of request channel signaling power and adjacent channel signal power in the OFDM signal receiver indicated to claim 1.
[Claim 3] The OFDM signal receiver with which the degree of change of the discrete fourier circuit (DFT) input signal power is characterized by having responded to the ratio of the input power to the digital filter for clinch component removal after a digital rectangular cross recovery, and output power in the OFDM signal receiver indicated to claim 1.
[Claim 4] The OFDM signal receiver with which the degree of change of the discrete fourier circuit (DFT) input signal power is characterized by having responded to the ratio of the absolute value sum of the input signal to the digital filter for clinch component removal after a digital rectangular cross recovery, and the absolute value sum of an output signal in the OFDM signal receiver indicated to claim 1.
[Claim 5] It is the OFDM signal receiver characterized by asking for the ratio of request channel signaling power and adjacent channel signal power from the discrete Fourier transform circuit output signal in the OFDM signal receiver indicated to claim 2.
[Claim 6] The OFDM signal receiver characterized by the degree of change of the discrete fourier circuit (DFT) input signal power having responded to the ratio of the absolute value sum of the amplitude of a request channel band and the absolute value sum of the amplitude of an adjacent channel band in the discrete Fourier transform circuit output in the OFDM signal receiver indicated to claim 1.
[Claim 7] It is the OFDM signal receiver characterized by guessing the ratio of request channel signaling power and adjacent channel signal power in the OFDM signal receiver indicated to claim 5 from the power of the specific frequency in the adjacent channel band after discrete Fourier transform.
[Claim 8] The OFDM signal receiver characterized by the degree of change of the discrete fourier circuit (DFT) input signal power having responded to the magnitude of the absolute value of the amplitude in the specific frequency in the adjacent channel band after discrete Fourier transform in the OFDM signal receiver indicated to claim 1.
[Claim 9] The OFDM signal receiver characterized by what it opts for when the degree of change of the discrete fourier circuit input signal power combines the approach indicated to claim 2 - claim 8 in the OFDM signal receiver indicated to claim 1.
[Claim 10] It is the OFDM signal receiver characterized by realizing when change of the discrete fourier circuit input signal power changes the magnitude of the input signal to an analog / digital converter in the OFDM signal receiver indicated to claim 1 - claim 9.

[Claim 11] It is the OFDM signal receiver characterized by realizing when change of the discrete fourier circuit input signal power changes the digital filter output signal for clinch component removal after a digital rectangular cross recovery in the OFDM signal receiver indicated to claim 1 - claim 9.
[Claim 12] It is the OFDM signal receiver characterized by realizing when change of the discrete fourier circuit input signal power combines claim 10 and claim 11 in the OFDM signal receiver indicated to claim 1 - claim 9.
[Claim 13] The OFDM signal receiver characterized by being small-scale to the digital filter for clinch component removal after a digital rectangular cross recovery, and using the loose filter of a barrier property in the system by which it is assumed that are in the orthogonal frequency division multiplex (OFDM) transmission system with which line type modulation of each subcarrier was carried out, and an adjacent channel exists near the request channel, using a comb mold filter in the object for adjacent channel signal removal.
[Claim 14] The OFDM signal receiver characterized by making only the signal band decreased with a comb mold filter amplify with the digital filter for component removal by return in the OFDM signal receiver indicated to claim 13.
[Claim 15] The OFDM receiver characterized by not using a comb mold filter in the OFDM signal receiver indicated to claim 13 or claim 14 when an adjacent channel does not exist, or when adjacent channel power is sufficiently small.
[Claim 16] The OFDM receiver characterized by using an approach according to claim 2 to 7 as an approach of determining whether use a comb mold filter in the OFDM signal receiver indicated to claim 13.
[Claim 17] Communication system characterized by using the receiving set indicated to claim 1 - claim 16.

[Translation done.]